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| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
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| 10/026,378 | 12/21/2001 | Jing-Pei Chou | 000761/P11 | 8194 |

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| EXAMINER | |
|---|---|
| PADGETT, MARIANNE L | |

| ART UNIT | PAPER NUMBER |
|---|---|
| 1762 | 6 |

DATE MAILED: 04/14/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

# Office Action Summary

| Application No. | Applicant(s) |
|---|---|
| 10/026,378 | Chou et al |
| **Examiner** | **Group Art Unit** |
| M.L. Padgett | 1762 |

*—The MAILING DATE of this communication appears on the cover sheet beneath the correspondence address—*

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, such period shall, by default, expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

☒ Responsive to communication(s) filed on 12/21/01 & 6/17/02

☐ This action is **FINAL.**

☐ Since this application is in condition for allowance except for formal matters, **prosecution as to the merits is closed** in accordance with the practice under *Ex parte Quayle,* 1935 C.D. 11; 453 O.G. 213.

**Disposition of Claims**

☒ Claim(s) 1-73 is/are pending in the application.

Of the above claim(s) _____ is/are withdrawn from consideration.

☐ Claim(s) _____ is/are allowed.

☒ Claim(s) 1-73 is/are rejected.

☐ Claim(s) _____ is/are objected to.

☐ Claim(s) _____ are subject to restriction or election requirement

**Application Papers**

☐ The proposed drawing correction, filed on _____ is ☐ approved ☐ disapproved.

☐ The drawing(s) filed on _____ is/are objected to by the Examiner

☐ The specification is objected to by the Examiner.

☐ The oath or declaration is objected to by the Examiner.

**Priority under 35 U.S.C. § 119 (a)-(d)**

☐ Acknowledgement is made of a claim for foreign priority under 35 U.S.C. § 119 (a)-(d).

☐ All ☐ Some* ☐ None of the:

☐ Certified copies of the priority documents have been received.

☐ Certified copies of the priority documents have been received in Application No. _____.

☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a))

*Certified copies not received: _____.

**Attachment(s)**

☒ Information Disclosure Statement(s), PTO-1449, Paper No(s). 4

☒ Notice of Reference(s) Cited, PTO-892

☐ Notice of Draftsperson's Patent Drawing Review, PTO-948

☐ Interview Summary, PTO-413

☐ Notice of Informal Patent Application, PTO-152

☐ Other _____

**Office Action Summary**

1. Claims 1-73 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Applicants have put chemical formulas in parenthesis in their claims, which is OK, as long as the meaning of those formulas is clear. TiN is a known compound, but the examiner knows of no compound with the formula TiSiN, because that creates stoichiometry of one Ti to one Si to one N which appears improbable. Page 2 of the specification where like nomenclature is used, provides no further clarification. When elements are written with chemical formula nomenclature, they will be assumed to be a chemical formulas, unless there is some clear indication on the record to the contrary. In the case of TiSiN, this formulae is chemically suspect, hence the meaning is uncertain, and clarification on the record is needed. Providing support for applicants intended meaning is recommended.

Claim 13 is vague and indefinite as it suggests that a "hydrogen-containing plasma" maybe produced from gases containing no H, since only one gas need be selected, and it maybe $N_2$, Ar or He. This would potentially contradict the name of the plasma or have the hydrogen coming from some of other source, suggesting that the intended meaning is not clearly present. Also see claims 13, 38, 49, 60 and 72.

Claim 15 has two identically claimed steps, (b) and (d). As written, there is no difference between them. Unless given some specific temporal limitation or antecedence, either (b) or (d) can be preformed at any time after any claimed by-products have been formed, i.e. during TiN

Padgett



~~particular significance to the option of use of the inorganic $TiCl_4$ as a precursor, as it provides for removal of Cl content (col. 4, lines 43-52) from the deposits.~~

~~5. Ho et al is of interest for providing further reasons for the significance of post-deposition plasma treatments to the surface microstructure of TiN films.~~

15 (5) Claims 1-2, 5-6, 10, 13-16, 19-20, 24-27, 30-31, 35, 38-39 are rejected under 35 U.S.C. 102(e) as being clearly anticipated by Shue et al, as applied in section 6 of paper #6

Claims 3-4, 7-9, 11-12, 17-18, 21-23,28-29, 32-34 and 36-37 are rejected under 35 U.S.C. 103(a) as being unpatentable over Shue et al, optionally in view of Sivaram (as discussed above), as applied in section 6 of paper #6

Applicant appears to argue that Shue does not teach the claimed process, by listing a sequence of steps that will effect the claimed process, then saying they are not doing what's claimed. the only words that differ, are explicit recitation of removal of reaction-by-products, however as previously noted Shue et al does teach explicit removal of by products, even if applicants leave it out of their recitation (col 6, lns 35-39), as well as noting that employing conventional CVD techniques (col 5, lns 5-19) means one will be using the usual continuous gas flow and exhaust system that is standard and causes inherent continuous removal of by-products, as is explicitly discussed in Sivaram et al. Applicant's have provided no limitations or arguments that demonstrate their process from standard conventional CVD gas flow techniques,

21 (6) Claims 40-73 are rejected under 35 U.S.C. 103(a) as being unpatentable over Shue et al, in view of Lu ~~(as discussed above)~~ and optionally Sivaram, as discussed in section 7, paper #6, and above

formation or thereafter. Order of listing does not necessitate any order of preforming, unless so specified. Note this consideration applies to all the claims for interpretation, not just 15.

The claim 26 or 62 preambles require the formation of "a barrier layer", however the bodies of the claims have no steps that require any such formation. (Also barrier to what?). While any of the layers recited in the steps of the process, may or may not be a barrier layer, there is no positive recitation of any barrier layer formation, so its relationships to the claims is unclear, or only implies (not claims) an intended use. Note because of this claim 26 and its dependants are equivalent as written to claim 1 and its dependants, except any metal layer is the last layer, likewise for claims 40+ and 62+.

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless -
>
> (e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraphs (1), (2), and (4) of section 371© of this title before the invention thereof by the applicant for patent.

The changes made to 35 U.S.C. 102(e) by the American Inventors Protection Act of 1999 (AIPA) do not apply to the examination of this application as the application being examined was not (1) filed on or after November 29, 2000, or (2) voluntarily published under 35 U.S.C. 122(b). Therefore, this application is examined under 35 U.S.C. 102(e) prior to the amendment by the AIPA (pre-AIPA 35 U.S.C. 102(e)).

3. Claims 1-9, 26-34, 40-45 and 62-67 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lu, in view of Sivaram.

The patent to Lu teaches making Ti-Si-N films via first depositing TiN via a CVD thermal deposition process that introduces an organometallic precursor compound in to the reactor using carrier gases, such as He or $N_2$. Use of standard processing techniques is taught, but not set out in detail (abstract; flow chart on cover; col. 2, lines 16-48; and col. 3, lines 30-67).

After TiN film formation, a post treatment employs pure or diluted silane or disilane (i.e. may use a carrier gas) is preformed, either in the same chamber or moved to a separate, but parallel reactor (col. 4, lines 1-17). Thereafter, a metal layer, such as Ti, may be formed thereon, which may be used as a barrier layer (col. 4, lines 22-38).

Lu differs from the claims by not discussing removal of reaction by-products and use of purge gas, and from some dependant claims by using metal organic precursors instead of $TiCl_4$+$NH_3$. However, while Lu does not discuss his gas flow, he is inputting gas at low pressure (0.1 to 50 torr), which implies the use of vacuum and output of gases, hence by-products, will be inherently continuously removed in the course of implementing the taught standard processing

steps, which would have been obvious to any one of competent skill in the CVD art. The except from the CVD text by Sivaram, is supplied to optionally support these assertions, Note on page 1, therein listed a series of "quasi steady-state subprocess" culminating in film formation, where items (d) desorption of reaction by-products, and (e) diffusion of the by-products away from the surface, indicate that the claimed removal of by -products is an ongoing and inherent part of the CVD process. Chapter 5 also shows a variety of CVD reactors, noted on p. 59-60 as useful for thermal CVD, all of which involve gas flow during the CVD process, hence it would have been further obvious for one of ordinary skill to use standard techniques as claimed and taught in Lu's Ti-Si-N deposition. Note as Lu's Si deposit step is done with different gases and possibly in different chambers, it would have been further obvious to one of ordinary skill to flush out all trace of the first deposition gases before either inputting the silane containing gas or opening the chamber for transfer to the parallel reactor, as organometallics are more expensive than carrier gases, so disadvantages to waste, and one would want to avoid contaminating supplies or areas exterior to the chamber. Flushing or purging is a standard operating procedure for cleaning and optimizing gas use. Note purge times of "up to about 5 minutes, include zero minutes.

While Lu uses the organometallic TDMAT, instead of the $TiCl_4$+$NH_4$ of applicants' dependant claims, the inorganic precursors are old and well known form deposition of TiN films as seen in either Lu's background (col. 1, lines 38-55) or in Sivaram (p. 199-201), hence it would have been obvious to one of ordinary skill in the art, to use alternate depositions precursors for TiN as known in the art, depending on ones resources and the end use, i.e. type of device

fabrication contemplated. $TiCl_4$+$NH_3$ as discussed in Sivaram has superior conformality, hence one would have been motivated to use such it as analternetive when increased comformality was important.

4. Claims 10-25, 35-39, and 46-61 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lu in view of Sivaram as applied to claims 1-9, 26-34, 40-45 and 62-67 above, and further in view of Kim et al (GB) or Sandhu (071) or Foster et al .

Lu does not teach the claimed treatment with a hydrogen containing plasma, however this technique is well known in the CVD-TiN formation art, as shown by the teachings of Sandhu (abstract; col. 3, lines 7-43; col. 4, lines 9-50 and table in col. 5, noting claimed gases, times, timings and substantiation of the effect of removing by-products, plus the background on lines 27-45+ indicates use of like precursors); Kim et al (abstract; page 2, line 21- p. 3, line 23 with treating uses $N_2$+$H_2$ gas for 10-60 sec, and following disclosure concerns by -product release and removal); or Foster et al (abstract; col. 1, lines 5-35; summary; col. 3, lines 42-col. 4, line 28 where thermal CVD using $TiCl_4$+$NH_3$ was employed, followed by plasma annealing with $NH_3$ for 15 to 300 sec). It would have been obvious to one of ordinary skill in the art to employ the H-containing plasma treatments to the TiN films deposits in Lu, as they provide the advantage of effectively removing undesirable leftovers from the CVD processes thereby improving the resistivity of the film, and would have been advantageous regardless of the subsequent Si-containing processing, because the removed by-products of the CVD reactions are not desirable for or cause contamination in the silane containing deposition process. Note that Foster et al, is of

particular significance to the option of use of the inorganic $TiCl_4$ as a precursor, as it provides for removal of Cl content (col. 4, lines 43-52) from the deposits.

5. Ho et al is of interest for providing further reasons for the significance of post-deposition plasma treatments to the surface microstructure of TiN films.

6. Claims 1-2, 5-6, 10, 13-16, 19-20, 24-27, 30-31, 35, 38-39 are rejected under 35 U.S.C. 102(e) as being clearly anticipated by Shue et al .

Claims 3-4, 7-9, 11-12, 17-18, 21-23,28-29, 32-34 and 36-37 are rejected under 35 U.S.C. 103(a) as being unpatentable over Shue et al, optionally in view of Sivaram (as discussed above) .

In Shue et al, see the abstract; flow chart of fig. 4; col 3, lines 10-65; col., 5 lines 6-19 and 45-65; col. 6, line 1- col. 7, line 12; and claims 1, 4, 5, 7, 8, etc., for the claimed procedure, excepting optimization of purge and carrier gases used in processing, however it would have been obvious to optimizes the taught removal of by products and purging. Sivaram optionally provides discussion on flow and removal of by-products as discussed above, which is also applicable to Shue et al.

7. Claims 40-73 are rejected under 35 U.S.C. 103(a) as being unpatentable over Shue et al, in view of Lu (as discussed above) and optionally Sivaram.

Shue et al does not teach moving to another chamber, but as seen in Lu, use of the same chamber or another for Si post-treatment may have been equivalently employed, hence would

have been obvious to one of ordinary skill due to expected like effects, and depending on production line constraints which may make one or the other configuration advantageous.

8. The reference to Zhao et al supplied by applicant, is of interest for depositing claimed material, but does so by direct deposition, not post CVD treatment. Iwasa and Park et al appear to merely teach uses of Ti-Si-N films, not the deposition technique.

9. Any inquiry concerning this communication should be directed to M.L. Padgett at telephone number 308-2336 on Monday-Friday from about 8:30 a.m. -4:30 p.m.; and Fax # (703) 872-9310 (regular); 872-9311 (after final) and 305-6078 (informal)

MPadgett:evh

4/2/03

4/10/03

MARIANNE PADGETT
PRIMARY EXAMINER